Agroecosystem diversification

E. Kabourakis
Ecological Production Systems Unit
National Agricultural Research Foundation
P.O Box 2229, 71003 HERAKLION, Crete GREECE
Tel. +30 2810 245851 Fax. +30 2810 245873
ekab@nagref-her.gr

Diversity in agroecosystems

- **Diversity of an agroecosystem it is ability to support sustainable functioning**
- **Diversity is the result of the ways that leaving and non living components are organised and interact**
- **Diversity makes possible the organisation and interactions of a production system**

Diversity in agroecosystems

- Diversity is an emergent quality of the whole system
- Conventional agriculture focus at individual and population level, a focus on control and simplification
  - To often eliminates beneficial interactions
- Sustainable agriculture focus at community and ecosystem level, a focus on management
  - Allows for management of beneficial, mutualistic and synergistic interactions

Diversity in agroecosystems

- **Diversity in agroecosystems is difficult to maintain due to:**
  - **frequent and intense disturbance**
  - **lack of succession development**

- **Loss of diversity in agroecosystems breaks the functional links between species resulting:**
  - **alternation of energy flow**
  - **changes in rate and efficiency of nutrient cycling**
  - **increase dependence on human inputs and interference**

Level of diversity

The level of diversity depends on:

- **The diversity of vegetation within and around the agroecosystem**
- **The permanence of various species within the agroecosystem**
- **The intensity of management**
- **The extent of isolation of the agroecosystem from natural vegetation**

Levels of diversity in agroecosystems

Diversity can be assessed at different levels:

- **Regional level: determined by soil, climate, topography and socio-economic constrains**
- **Individual farm: determined by geographical, biological and socio-economic factors**
- **Within farm diversity: different cropping systems, rotations, etc.**
- **Within agroecosystem diversification among species**
- **Within species variation**

Types of diversity

- **Species: number of different species**
- **Genetic: variability of genetic material within each species and among different ones**
- **Vertical: number of horizontal levels**
- **Horizontal: pattern of spatial distribution of organisms**
- **Structural: number of niches in the agroecosystem**
- **Functional: complexity of interactions, energy flows, nutrient cycling among the agroecosystem components**
- **Temporal: degree of heterogenity of daily, seasonal, etc. cyclic changes**

Value of diversity

- Increases the opportunities for coexistence and beneficial interference between species
- Open habitats can be colonised by useful species
- Beneficial population dynamics among herbivores and their predators
  - population of individual herbivores are controlled
  - a pest herbivore can not become dominated in order to thread the crop

Value of diversity

- **Better resource use efficiency due to:**
  - **adaptation to habitat heterogeneity – greater habitat differentiation**
  - **complementarily in plant needs – more opportunities for coexistence and mutualisms**
  - **diversification of the niche**
    - **open habitats can be colonised by useful species**
  - **overlap of niche**
  - **beneficial population dynamics between predators and pray**
  - **Better resource efficiency**
  - **partitioning of resources**
  - **Protect biodiversity**
  - **Performance of ecological services**
- **Reduced farmer economic risk especially in under unpredictable environmental conditions**
- **Diversity of microclimates attracting and occupied by noncrop organisms**

Value of diversity

- **Diversity in the agricultural landscape contributes to conserve biodiversity in surrounding natural ecosystems**
- **Diversity of soil fauna and flora performs services such as:**
  - **nutrient recycling**
  - **regulation of local hydrological processes**
  - **breakdown of chemicals**

Methods of increasing diversity in agroecosystems

- add new species
- reorganise or restructure the existing species
- add inputs or farming methods that enhance diversity
- eliminate inputs or practices that restrict diversity

Methods of increasing diversity

- Multicropping
- Strip cropping
- Hedgerows and buffer vegetation
- Cover cropping
- Rotations
- Fallow
- Minimum tillage or reduced tillage
- Organic matter additions

Multicropping

- Growing two or more crops together in mixture
- Intensifies and diversifies cropping in time and space
- Temporal diversity through sequential (staggering) planting of different crops
- Horizontal, vertical, structural and functional diversity through the presence of more than one crop
- E.g. olives, with vines, fig trees, etc.

Strip cropping

- Planting of different crops in adjacent strips (polyculture of monocultures)
- It is more practical method of increasing diversity for some crops
- It increases diversity across communities

Hedgerows and border planting

- Trees or plants planted around the perimeter or the boundaries of the agroecosystem
- Functions:
  - wind breaks
  - exclude (enclose) animals
  - produce fruits and other products
  - attract and provide habitat to beneficial
  - buffer zones between different systems
  - increase overall diversity at regional level and landscape level

Cover cropping

- Noncrop species planted in a field to provide soil cover
- Species range from annual to perennial
- Includes different taxonomic species
- Benefits of cover cropping:
  - enhances organic mater
  - stimulates soil biological activity and fauna
  - prevents losses of nutrients
  - prevents water runoff
  - reduces soil erosion
  - leguminous crops fix nitrogen
  - provides habitat for beneficials
  - inhibit weeds

Rotation

- Increases diversity over time by planting different crops in recurring sequence

- Alternation of crops makes cover crops grown better than when grows continuously in a monoculture due to:
  - ecological impacts in the soil
  - maintaining rigorous soil biological activity
  - improving soil fertility (chemical, biological, physical)
  - accumulate organic matter

Minimum tillage

- Minimum tillage reduces system disturbance
- Increased earthworm populations and soil fauna activity
- Diversified soil organic mater decomposing organisms
- Improved
  - soil structure
  - nutrient holding capacity
  - organic mater content

Fallow

- **The soil for a period in the cropping sequence is left uncultivated**
- **The fallow period:**
  - **allows succession and recovery of the diversity in the soil**
  - **rainfall recharges soil moisture reserves**

Minimum tillage

- Minimum tillage reduces system disturbance
- Increased earthworm populations and activity
- Diversified soil organic mater decomposing organisms
- Improved
  - soil structure
  - nutrient holding capacity
  - organic mater content

Addition of organic mater

- Increased levels of soil organic mater stimulate structural and functional diversity of the soil biota

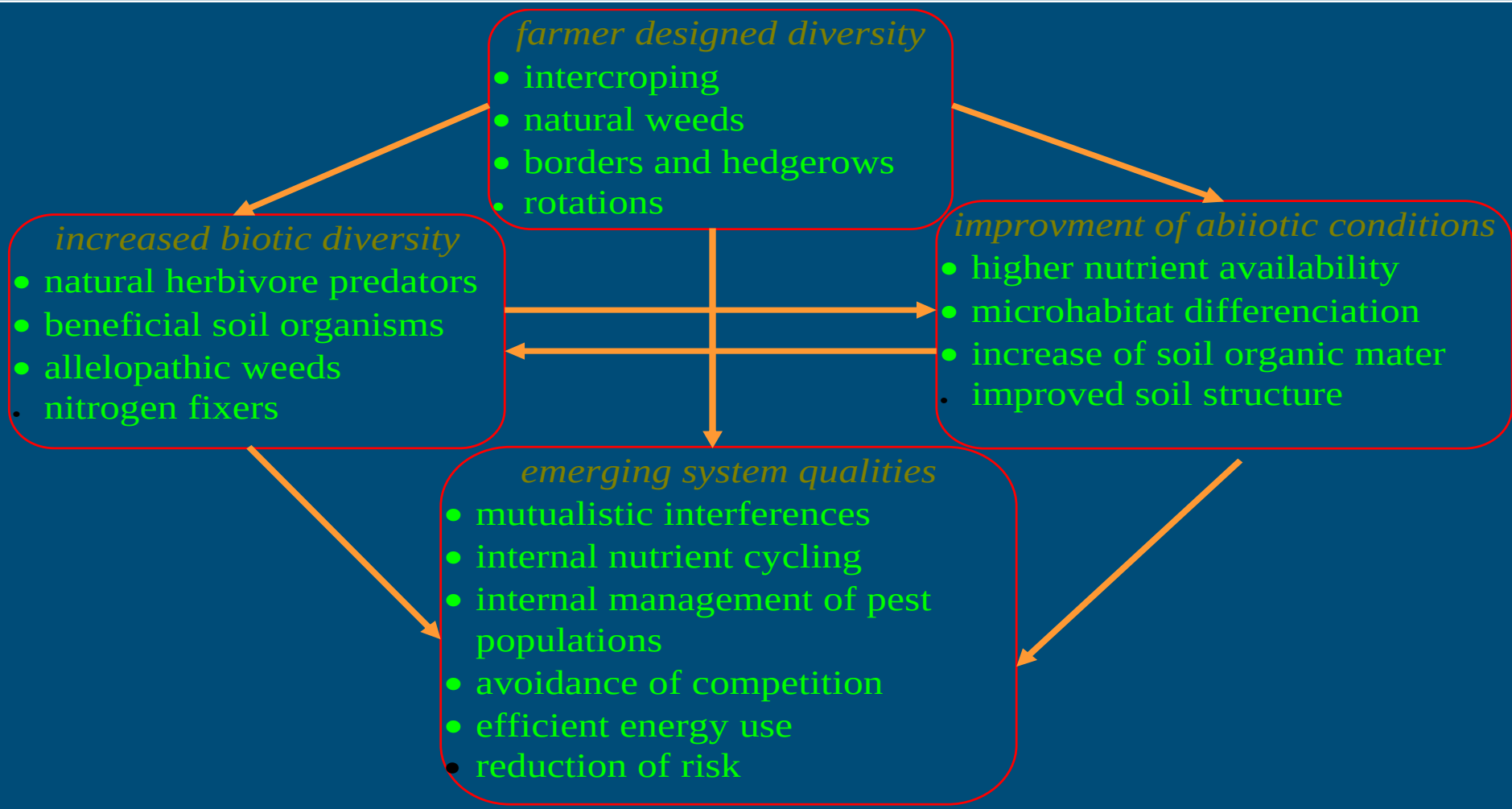
- Organic matter:
  - provides nutrients
  - improves soil structure
  - increase nutrient and water retention
  - decreases soil compaction
  - is a food source for soil organisms

Management of diversity

- **Species composition is more important often than number of species per se**

- **Managing diversity:**
  - **involves higher risk**
  - **creates more uncertainty**
  - **makes farmer work more complicated**
  - **practical difficulties in management**
  - **yield may decrease because of adverse interference**

System dynamics in diversified agroecosystems



Decreased biodiversity

- **Agroecosystem genetic homogeneity allows standardisation of management practices and mechanisation**

- **Agroecosystems more susceptible to:**
  - **insect pest and pathogens**
  - **changes in the environment and climate**

Management of diversity in agroecosystems

How do we arrange multiple crops?

Arrangements in time and space

- Association in time and space in the same field during the same crop or planting cycle
- From rows or lines to borders or sub plots

  to

  intercropped or mixed crops
- Intensity of interaction between components and our management capacity

How do we evaluate multiple crops?

Land evaluation ration (LER)

- LER provides a measure of the yield advantage obtain by growing two or more crops in polyculture

- LER = (Ypa / Yma)+ (Ypb / Ymb) + (Ypd / Ymd) +....
  - Yp = yield of each crop in the polyculture
  - Ym = yield of each crop in a monocutlure
  - the ration (Ypi / Ymi) determines the partial LER of each crop

	yield in polyculture *Yp (kg/ha)*	yield in monoculture *Ym (kg/ha)*	partial LER *Yp/Ym*
Crop A	1000	1200	0.83
Crop B	800	1000	0.80
			LER = 1.63

Ecological valuation

vs

economic evaluation